UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

Project | Date | Author

TITLE

PLANTATION INSECTS AT THE INSTITUTE OF FOREST GENETICS

PLACERVILLE, CALIFORNIA
Season of 1939

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Berkeley, California
February 20, 1940

U. S. GOVERNMENT PRINTING OFFICE 8—9742

SUBJECT—

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Berkeley, California
February 20, 1940

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PLACERVILLE, CALIFORNIA

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INTRODUCTION

In the past the insects attacking reproduction in the pine forests of the California region have received only intermittent observations incidental to other studies. With the great increase in conservation and reforestation activities which has taken place in recent years however, these insects have attained a more important place. This is particularly true where trees are grown under nursery and plantation conditions, for not only are actual values greater than for natural reproduction but with the concentration of suitable host material the insects can increase their numbers more rapidly and thus do more damage than would normally occur in scattered groups of reproduction in the forest.

A more intensive study of these insects has therefore been taken up in order to learn more of their habits, to evaluate the extent of injury caused, and to investigate possible methods of control. All observations and control tests were made at the Institute of Forest Genetics, Placerville, California. Here the Forest Service maintains experimental plantings for the purpose of developing a superior type of tree for reforestation, and since each tree is part of an investigative study, the values involved are even greater than those in nurseries producing planting stock. A period of intensive work was carried on in the spring during the height of insect activity and periodic examinations were made during the remainder of the season. Mr. Lloyd Austin, in charge of the Institute, was most helpful in furnishing laboratory space, trees for experimental work, and the services of a non-technical assistant for a part of the season.

The principal arthropod pests occurring in the plantation are the resin midge, a mite or red spider, aphis, a tip moth, a clear wing pitch moth, and two cone insects. Several other species are present but cause only minor injury.

RESIN MIDGE (Retinodiplosis sp. near inopsis O. S.)

This is the most injurious pest in the plantings and is becoming more serious from year to year. Few trees have been killed but many are now valueless for growth studies.

Stages in the Life Cycle

The adult is a small cecidomyid 3.5 mm. long with black head and thorax, and orange abdomen. The eggs have the typical elipsoid form common in dipterous species; the size is 0.4 mm. x 0.1 mm.; the color is crimson becoming lighter before hatching. The newly hatched larva is approximately the same size as the egg and is pale vermillion in color. The fully grown larva is 4 to 5 mm. long; the body is flattened dorso-ventrally and the surfaces are rugose; the color is bright orange. The pupal stage forms within the parchment-like, last larval skin; the color of the pupa within changes from orange to white, and finally to black.

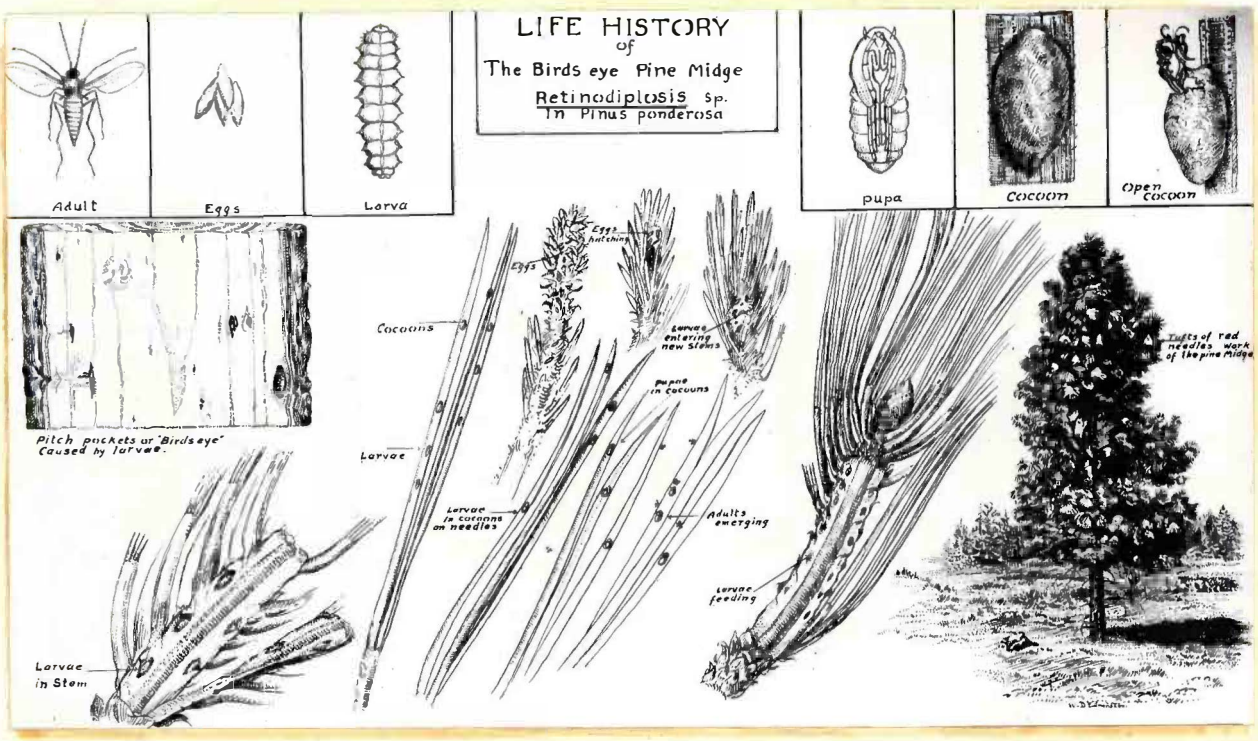
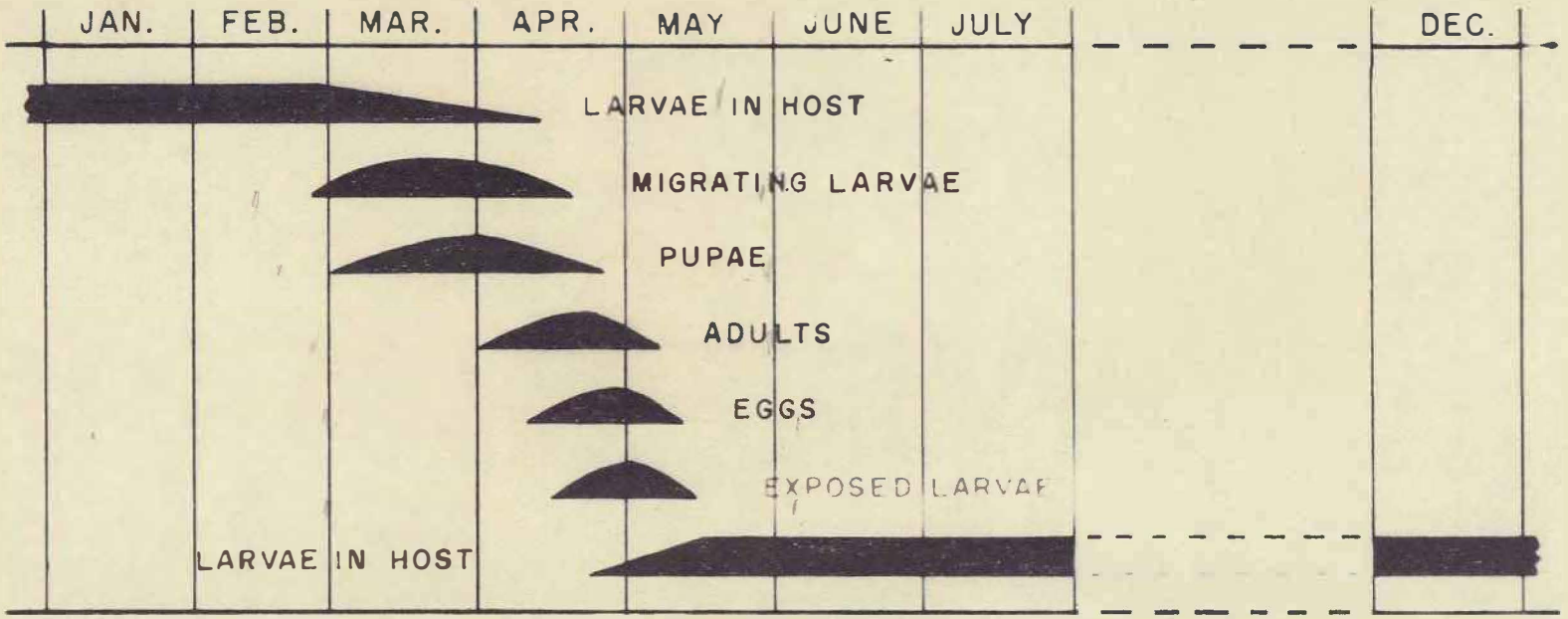


Figure 1. (8519)



RESIN MIDGE — *RETINODIPLOSIS* SP.

LIFE CYCLE SEASON 1939

Figure 2

Life History and Habits

The stages in the life cycle and their time of occurrence are shown in Figures 1 and 2. The dates given are based primarily on the observations of the past season and will no doubt vary from year to year. The first adults appear around the first of April and the greatest numbers are present two or three weeks later; the flight ended about the second week in May in the past season but there are records of adults being present in June. The length of life of the individuals was found to range from 5 to 12 days under laboratory conditions. The period of daily activity seems to be governed principally by light and temperature conditions, for it was observed that the midges remained quietly hidden in the foliage of the trees during the warmer part of the day or when there was any appreciable air movement. In the middle of the afternoon when the temperature fell to about 75° to 80°, they would start flying about, mating and ovipositing; this would continue until dark when all activity ceased until the next afternoon. There was no movement during the early morning hours. These midges are not strong fliers apparently passing the entire adult period on or near the same tree on which they develop. This habit coupled with limited period of daily activity and the aversion to wind is probably the reason for the slow spread of the infestation through the plantings.

The adults are fully developed when they escape from the puparium and mating takes place within a short time. Each female contains 80 to 100 eggs which are deposited within a few days. They are placed singly and in groups of several on the new growth of the host trees, mostly just behind the needle bases. They are not forced into the tissue but simply placed upon the surface. On the fourth day after being deposited the eggs become lighter in color except for a crimson spot in the center, and on the sixth day the larvae hatch. They immediately start working into the soft tissue of the new growth through the natural creases and depressions. In four to six days the larvae are completely embedded and here they remain, feeding and growing, until the following spring when they become fully developed and migrate out on the needles to pupate. This period of migration begins in March and ends in the latter part of April. The pupa forms on the second day after the larva settles on the needle. One week later the pink color changes to white and at the end of the second week the color changes to black. Emergence of the adult takes place at the end of the third week thus completing the life cycle. In so far as we know there is only one generation a year.

Distribution and Hosts

This insect, or closely related species, is found throughout the forests of the California region, and is perhaps widely distributed in the pine forests west of the Rockies. The preferred hosts are Pinus ponderosa ponderosa and P. ponderosa scopulorum the insects selecting these two varieties almost exclusively.

In the plantation at the Institute specimens of P. ponderosa arizonica (68-29), P. apacheca (66-30), and P. jeffreyi (72-32, 73-28, 70-33) were found to be lightly infested. All but one Jeffrey pine (73-28) however, were atypical individuals resembling closely one of the more susceptible varieties of ponderosa pine. In general, sapling to pole size trees are preferred although severe attacks on larger trees have been observed. No small seedlings have been infested as yet.

Type of Injury

The injury to the trees is caused entirely by the larvae. The feeding pits formed in the soft tissue of the new growth interrupt conduction and growth. If sufficiently numerous they may, in effect, girdle the twig which results in a characteristic "flag" of dead foliage. More commonly the pits are not sufficiently numerous on any given twig to kill the tip, but instead they pour out copious amounts of resin, when the larvae migrate in the spring, and eventually heal over. The presence of these pits causes a distortion of the growth of the infested parts which in severe cases, gives the tree an almost fantastic appearance. The bird's-eye effect occasionally seen in ponderosa pine lumber is believed to be caused by old feeding pits which have become embedded in radial growth (Figures 3 and 4).

There seems to be a wide difference in susceptibility of individual trees to attack by this insect. This seems particularly true of trees from different hereditary strains. The reason for this range of susceptibility is not apparent but it was observed that the ovipositing females seem to be attracted to those trees on which the new growth in the spring carries a sticky resinous exudation. Trees on which the new growth was dry or carried a waxy "bloom" seemed to be much less attractive to the females although the larvae developed normally in cases where eggs were deposited. A further check on this point will be made next year if possible.

Parasites and Associated Insects

In heavy infestations of resin midge which occassionally develop in natural reproduction the numbers are brought to a normal state within a few years by natural enemies--chiefly parasites. In the plantation at the Institute the parasites are present but as yet they have not checked the infestation. The most common is a small hymenopterous egg parasite (Hopk. U. S. 32619 a.). The females were seen running about over the infested trees and freely ovipositing in the eggs and newly hatched larvae of the resin midge. The parasite larvae develop within the host larva but the latter does not die until just before or just after it reaches the pupal stage. The parasites then pupate within the body of the host and the adults emerge in synchronization with the oviposition period of the midge. Four to twenty individuals may develop within a single midge larva. The principal shortcoming in the work of this species is that the larvae of the midge are not killed until the end of the feeding period. Several other hymenopterous parasites (Hopk. U.S. 32619b, d to i) were reared from pupae of the

Figure 3. A tree which has been heavily attacked by resin midge. Note the dead needles and badly twisted lateral growth. (9915)

A B C D

Figure 4. Old injuries caused by resin midge. A, distorted growth in small twig; B, openings of old pits which are healed over; C and D, old pits which have lignified and healed over to form a "bird's eye" spot. (6783)

resin midge, but they were not sufficiently numerous to cause any appreciable reduction in the host population.

In examining samples of the previous year's growth, several pits were found which differed from those made by the resin midge larvae in that they were larger, more open, and were often filled with slimy, necrotic tissue. Each contained several larvae instead of only one or two as is typical of those made by the resin midge. The larvae themselves are dipterous and superficially resemble those of the resin midge, but they are smaller, less rugose, and paler in color. The question immediately arose as to whether this was a secondary species or an immature form of the pest being studied. The adults which were reared were sent to Washington for determination (Hopk. U.S. 32621).

Control Tests

Several small scale tests were made with hand equipment to determine whether satisfactory control of the resin midge could be effected by use of insecticides. Since during most of the life cycle the insects are within the host, any spray application would necessarily have to be carefully timed for the short period when they are exposed. Applications of several different formulae were made when the first eggs had hatched, the object being to kill the new larvae, eggs, adults, pupae and stragglers of the migrating larvae all at one time if possible. Those formulae which gave the best coverage and persistence were then applied on two series of trees at 10 and 20 day intervals respectively, until the last eggs hatched. The formulae used, schedules applied, and general observations are given in Table 1.

Definite evaluation of these formulae will not be possible until next spring, but examination of sprayed tips 24 hours after application indicate that most of the treatments were ineffective because of poor wetting. A fairly good kill of eggs and new larvae was obtained with Numbers 8, 2 and 6 (apparent effectiveness in the order named), but apparently none would kill the pupae. A further difficulty lay in the fact that the oviposition period coincides with the period of terminal growth in the host trees; consequently, either sprays must be applied at frequent intervals to protect the expanding tips, or else, as suggested above, a method must be developed which will kill eggs, exposed larvae, pupae and adults in one shot. Since repeated applications would be exceedingly expensive and also might cause injury to the trees, further work should be on the development of the single treatment. At present further tests should be made to secure materials which will give better coverage of terminal buds and of the puparia of the resin midge. The use of hand equipment in testing insecticides is, of course, definitely limited in that the working pressures are inadequate and the areas covered are too small to give a valid measurement of the possible extent of protection. Any work beyond the selection of a few formulae which show promise of effecting protection will necessarily require the use of power equipment.

Should a satisfactory method of control be developed, an annual application would probably be necessary for several years to reduce the resin midge population to a non-injurious level. Later, applications might be made once in two or three years, but eradication cannot be expected. This is a native insect and despite its poor flight ability it would eventually migrate in from adjacent native trees.

Table 1. Spray Test - Resin Midge

Number	Ingredients*		Applications	Observations
1	Light medium oil	0.5%	10 day series	Covers needles well on breaking; irregular on terminals. Does not seem to wet puparia.
	Nicotine sulphate (40%)	1 pint	20 day series	
	Blood albumin	4 oz.		
	Liquid spreader (Ortho)	1 pint		
2	Light med. oil emul. (Nursery Volk)	1%	10 day series	Wets old and new growth well, but high run-off. Does not wet puparia.
	Nicotine sulphate (40%)	1 pint	20 day series	
	Liquid spreader (Ortho)	1 pint		
3	Diesel emulsion**	1%	10 day series	Wets foliage and stems well, but not terminals.
	Nicotine sulphate (40%)	1 pint	20 day series	
	Liquid spreader (Ortho)	1 pint		
4	Thiocyanate (Loro) grassellii	1:1000	1 only	Poor wetting.
	Liquid spreader (Orthoeilii)	12 oz.		
5	Light medium oil	0.5%	1 only	Irregular wetting on new growth.
	Nicotine sulphate (40%)	1 pint		
	Blood albumin	4 oz.		
6	Lead arsenate	3 lbs.	1 only	Puts on fair deposit but not as heavy as on lodgepole pine. Wetting fair to good on terminals.
	Light medium oil	1 pint		
	Kerosene	1 pint		
	"Dynamite" spreader	¼ lb.		
	Nicotine sulphate (40%)	1 pint		
7	Zinc nicotine thiocyanate	4 lbs.	1 only	Wets foliage well, fair around terminal.
	Light medium oil	1 %		
	Blood albumin	4 oz.		
8	Heavy oil and emulsifier (Fungicide adhesive)	1%	1, 4/17/39	Wets better than others & oil persists for some time. Frequent applications would probably cause injury
	Liquid spreader	1 pint	1, 4/28/39	
	Nicotine sulphate (40%)	1 pint		

* All quantities given are for 100 gallons of spray mixture.

** Stock emulsion: 10 parts Diesel oil, 5 parts Bentonite, 10 parts water - by weight.

SPIDER MITE (*Paratetranychus* sp.)

During the past two seasons this mite has been the second most injurious species in the Institute plantings. It has been tentatively identified as *Paratetranychus alpinus* Mc.G. (Hopk. U.S. 3622).

General Observations

The adults are small, about 0.4 mm. in length, and brown in color. The eggs are comparatively large in proportion to the adults and are deposited in a random manner over the foliage and twigs of the attacked trees. The newly hatched mites are a pale yellowish color and become darker as they mature. Little webbing is formed. From the observations at the Institute, it appears that when temperature conditions are favorable the mites remain active throughout the winter. The distribution of *P. alpinus* is unknown; the original description was made from specimens collected from incense cedar in Oregon. If ours is the same species it may well be that the distribution is quite general along the Pacific coast. The host selection seems to be quite wide; in the Institute plantings the mites were found on many species of *Pinus*, *Libocedrus decurrens*, *Chamaecyparis lawsoniana*, *Sequoia sempervirens* and *S. gigantea*. Trees covered with road dust and nursery stock seem to be particularly attractive.

Figure 5. Ponderosa pine showing faded needles which have died as a result of feeding of the spider mite, *Paratetranychus* sp. (11066)

The injury done by this species is typical of that caused by foliage feeding spider mites (Figure 5). The cell contents are sucked out and the needles slowly fade to a straw color. Injury is most severe in the tops although the whole tree may be affected. So far all of the infested trees of sapling size or larger have recovered the following season although the normal functions are seriously interfered with and repeated attacks might easily pave the way for engraver beetles or other enemies. Nursery stock and transplants probably would be more seriously affected than the larger trees, so all infestations in these have been promptly treated.

Control Tests

Several formulae were applied for control of the mites (Table 2). All gave good to excellent results although the heavy oils had a tendency to aggravate the injury caused by the mites. The proprietary emulsion of summer oil is probably the most reliable, considering both the safety of the foliage and the toxicity to the mites

Table 2. Tests for Control of Spider Mites

Number	Ingredients*		Results
R1	Heavy oil and emulsifier (Fungicide adhesive)	1%	Excellent control; fades injured foliage
	Nicotine sulphate (40%)	1 pint	
	Liquid spreader (Ortho)	1 pint	
R2	Light medium oil emulsion	1%	Good control; no foliage injury.
	Nicotine sulphate (40%)	1 pint	
	Liquid spreader (Ortho)	1 pint	
R3	Thiocyanate (Loro)	1:1000	Good control; poor wetting; no foliage injury.
	Liquid spreader (Grasselli)		
R4	Heavy oil and emulsifier	½ %	Excellent control; slight fading of foliage.
	Nicotine sulphate (40%)	1 pint	
	Liquid spreader (Ortho)	1 pint	
R5	Same as R2 plus		Control good; slight foliage fade; good wetting but high run-off.
	Sulphated alcohol (Dreft)	4 oz.	
R6	Same as R3 plus		Good control; slight foliage fade; good wetting but high run-off.
	Sulphated alcohol (Dreft)	2 oz.	

* All amounts are given in quantities to make 100 gallons of spray mixture.

APHIS (Several unidentified species)

Both stem and foliage feeding aphids were found to be present and some were attacking practically all species of pines present. The infestation was very heavy during the early spring, but natural enemies and the warm dry weather brought about natural control on the larger trees by the middle of May. A small brown stem infesting species caused considerable trouble in the nursery and new transplants throughout the spring and early summer; it and other species were satisfactorily controlled with the following formula:

Nicotine sulphate (40%)	1 pint
Liquid spreader (Ortho)	1 pint
Water to make	100 gallons

TIP MOTH (Rhyacionia zozana (Kear.))

For several years this insect caused considerable injury to the tips of ponderosa pine in the plantings and then for a few years became quite scarce. During the past season the amount of injury again began to increase - this time in the new transplants in the progeny block. According to Lange* the females deposit the eggs during April and May around the needle bases on the new growth. On hatching, the larva first feeds on the basal portion of the needles and then bores into the terminal. Here the feeding continues and the full grown larva pupates in the burrow in June. The winter is passed in the pupal stage and the adult emerges the following spring. There is no possibility of controlling the larval stage after it has entered the terminal so all effort must be directed toward the use of a method which will kill the eggs and newly hatched larvae. No work was done along this line during the past season because neither the time nor the material was available. If possible, some caged rearings will be carried on next season.

SEQUOIA PITCH MOTH (Vespamima sequoias Hy. Edw.)

This insect is a clear winged moth which deposits its eggs in wounds in pines and other conifers. Several pines in the arboretum have become infested along the leader where tie ropes on braces have broken the bark. The larvae feed upon the soft tissues beneath the bark and become covered by a heavy reddish pitch secretion. The only means of control is to remove the larvae from the pitch pockets by hand and then clean out and seal the wound. All tie ropes and props which might cause abrasions should, of course, be removed. The trees in the arboretum were all gone over last spring and the results have been quite satisfactory; the few pockets that were overlooked can be removed next spring. It would probably be advisable to check over the plantings each year.

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*Lange, W. Harry Jr. California Pine Tip Moths of the Genus Rhyacionia. Bull. of the Southern Calif. Acad. of Sciences. 36:25-34, 1937

CONE INSECTS

According to Mr. F. I. Righter of the Institute staff, considerable trouble has been experienced by insects destroying hand pollenated cones and seed grown for experimental work. The loss is greatest in years of poor cone crops in the forests; a reduced number of cones, of course, means a higher percentage of cones and seeds infested. The seed chalcid, Megastigmus albifrons Walk., and a cone moth, Laspeyresia sp., are the species responsible. In discussing the matter with Mr. Righter, Mr. Miller suggested that bags be kept over the developing cones during the time the insects are in flight - a period of about three weeks in the early summer just after the cones start the second year growth. Since the cones are kept in bags during a part of the second year to prevent squirrels from feeding, it would involve little extra work to put the bags on early enough to prevent oviposition by the insects. If desirable, entrance of sunlight and ventilation could perhaps be provided for by fine mesh screen windows.

INSECTS OF MINOR IMPORTANCE

There are several insects which are present each year and often are sufficiently numerous to give the impression that they are doing considerable damage. Actually the extent of injury has so far been inconsequential.

A weevil, Scythropus sp., is present in great numbers each spring and makes prominent serrate feeding marks on the needles of nearly all species of pine present.

A leaf feeding beetle, Glyptoscelis sp., feeds on the foliage of pines and other conifers.

A small lepidopterous defoliator, Cerostoma cockerella (Busck), webbs and feeds on the needlebases of ponderosa pine during the spring. These larvae may be confused with the small larvae of the tip moth, but unlike the tip moth larvae they do not enter the buds.